Dredging Research

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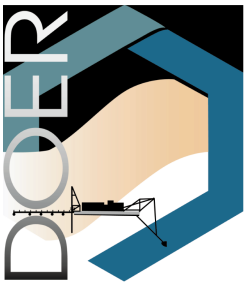
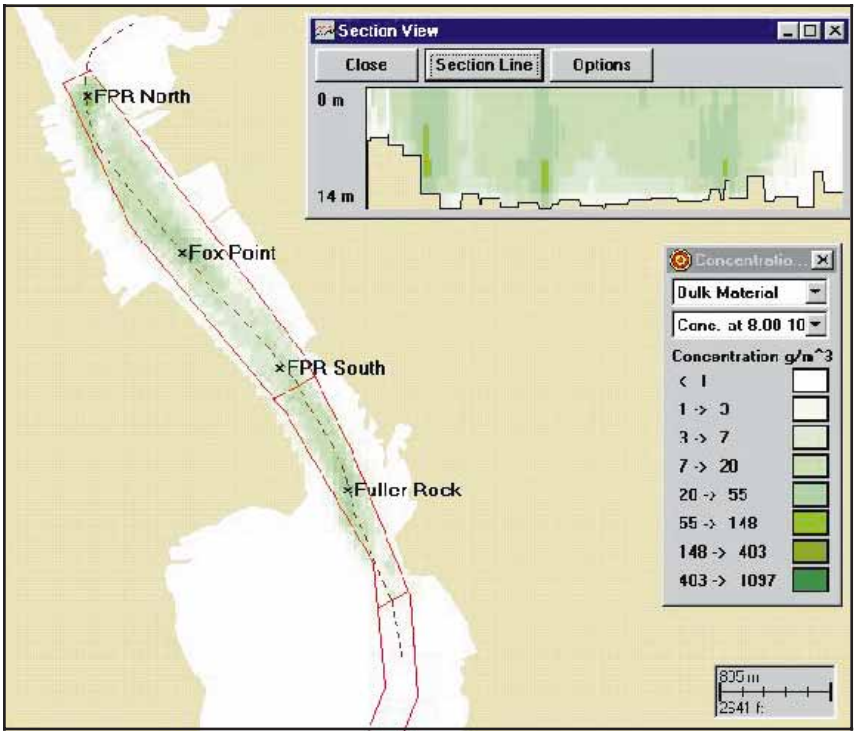
DOER-developed numerical modeling system SSFATE to assist with evaluation of Environmental Windows proposed for dredging projects



by Drs. Billy H. Johnson and Douglas Clarke, Engineer Research and Developement Center-WES

Some "What if" questions frequently asked during dredging project coordination are related to resuspension and dispersion of sediments at the dredging site. Suspended sediments are a primary concern of resource agencies, as exposure of aquatic organisms to elevated suspended sediment concentrations is perceived to be a source of detrimental impact. Likewise, redeposition of suspended sediments can be a concern if sensitive bottom-dwelling organisms (e.g., oysters or seagrasses) are present in the vicinity of a dredging project. Therefore, accurate information on the spatial dynamics of dredge-induced suspended sediments is critical when establishing the overall need for protective windows.



Maximum extent of sediment plume with bucket release rate of 2 percent for Fox Point Reach (FPR) North and Central sites and Fuller Rock site over the 3-day simulation time. Plan view shows release point, channel geometry, and maximum concentrations (mg/L) at 8-10 m (26-33 ft) depth. Vertical section shows distribution of maximum concentrations (mg/L) over depth along dashed section lilne shown in plan view. Concentration contours correspond to ranges in the Newcombe-Jensen fisheries impact model

graphical user interface allows animated model results

ERDC-WES scientists and engineers worked with Applied Associates, Inc., to develop the numerical modeling system called SSFATE (**S**uspended **S**ediment **FATE**) in response to the need for tools that assist dredging project managers when confronted by requests for environmental windows. In many cases,

In this issue . . .

decisions regarding environmental windows are based on limited technical information, with potential impacts linked to a host of site- and project-specific factors. For example, navigation dredging operations in different reaches of the same waterway may pose risks to different resources, or potential impacts may vary depending on the type of dredge plant involved. Before the development of SSFATE, few tools existed to evaluate such concerns during early interagency project coordination for environmental windows.

SSFATE development

During concept development for the SSFATE modeling system, it was recognized that to be truly effective as a dredging project management tool for windows, the system must be capable of running multiple simulations in a relative short time span. This speedy process would allow evaluation of a number of dredging alternatives, determining those with the least probabilities of detrimental impacts. The ability to display suspended sediments dispersed from a dredging site, in a format that can be merged with known distributions of biological resources, powerfully enhances impact assessments. Also, a "hands on" tool that would enable the dredging project manager or resource agency representatives to specify a range of simulated scenarios resulting in model solutions quickly available for interpretation would be a significant improvement over existing technologies.

SSFATE is a versatile computer modeling system, containing features required for addressing these environmental windows issues. For example, ambient currents, which are required for operation of the basic computational model, can either be imported from existing numerical hydrodynamic models or drawn graphically, using interpolation of limited field data. The modeling system employs a shell-based approach consisting of a color-graphics-based, menu-driven user interface; geographical information system (GIS) environmental data management tools; and gridding software. All of these tools interface with supplied input and display output data from the model. SSFATE runs on a personal computer, making extensive use of the mouse (point/click) and of pulldown menus.

Data input and output are interactive and are primarily graphics based. The system supports a full set of tools to allow the user to import data from standard databases, a wide variety of GISs, and other specialized plotting and analysis programs. SSFATE can be set up to operate at any dredging operation site and includes a series of mapping and analysis tools to facilitate applications. Initial setup for new locations of dredging operations can normally be accomplished in a few hours, unless numerical hydrodynamic models are run to provide flow fields.

At the heart of the system is a computational model, based on the concept of treating the suspended material as a series of particles, that predicts the transport, dispersion, and settling of suspended dredged material released to the water column as a result of dredging operations. An integral component of the modeling system is the specification of the sediment source strength and vertical distribution. At the present time, sediment sources in SSFATE represent the introduction of sediment into the water column as the result of a cutterhead, hopper, or clamshell dredge.

The application

In an application of SSFATE, the first step is to establish an operational area. Locations can include rivers, lakes, and estuarine systems on a spatial scale of up to tens-of-kilometers. For each location, the user supplies digital data describing the shoreline and the bathymetry. These data can be digitized from an appropriate map, obtained from digital databases, or produced by using an external GIS and then imported into the system.

The embedded GIS allows the user to input, store, manipulate, analyze, and display geographically referenced information. Additional information about geographically referenced data can be obtained through the use of linking procedures. These link files may include charts, graphics, tables, photographs, etc. Examples of data that might be stored in the GIS include physical characteristics of the dredged material, current meter data sets, and distributions of potentially impacted biota.

A suite of tools is provided within the SSFATE modeling system to import, export, and manipulate environmental data. As an example, time-series of scalar or vector data at single or multiple points can be imported, and spatial data can be imported for rectangular or boundary-fitted gridded regions. Through this procedure, data from external models (e.g., hydrodynamic models) or measuring systems (e.g., moored current meters) can be accessed and used as input to the SSFATE modeling system. Tools are also available to import and export data to or from other GISs and existing databases.

Model output

Model output includes animation of the particles representing each sediment type individually or all of the particles together over GIS layers depicting environmentally sensitive areas. Additional output includes: both horizontal and vertical concentration contours of each sediment type or a superposition of all suspended sediment; a time-series of suspended concentrations at a particular point; spatial distribution of sediment deposited on the sea bottom; and tabular summaries of how much sediment is in suspension, how much has been deposited, and how much is left in the grid. A contouring procedure is available to provide dredged material thickness distributions on the sea bottom and concentrations at user-defined depths in the water column. The user may select the contour intervals and threshold value. The user can interact with the contoured data to obtain pertinent information such as a cross-sectional view along a user-selected transect, the distance to features

from the sediment source, and the area covered by the material that has been deposited on the bottom.

In summary, SSFATE has been developed to satisfy a specific need for tools to aid in negotiation of Environmental Windows. Predetermined attributes of such a tool include the adaptability to a broad spectrum of dredging project scenarios, low "front end" requirements for input data or supporting hardware, efficient computational algorithms to enable multiple simulations in a short period of time, and effective means of output visualization. The strengths of SSFATE are in its versatility, simplicity, efficiency, and low cost of operation. Together with other tools that are under development in the DOER Program's Environmental Windows Focus Area, SSFATE represents a significantly improved capability for dredging project assessments. Dredging project managers and resource agency staff should be able to rapidly explore the impact of various dredging scenarios, and to optimize management options, including Environmental Windows, based on SSFATE results.

Additional information about SSFATE and Environmental Windows can be obtained from Dr. Billy H. Johnson, e-mail *johnsob1@wes.army.mil* or Dr. Douglas Clarke, e-mail *clarked@wes.army.mil* or from the Internet at *www.wes.army.mil/el/dots/doer*.

SERDP research results to benefit dredged contaminated sediment remediation

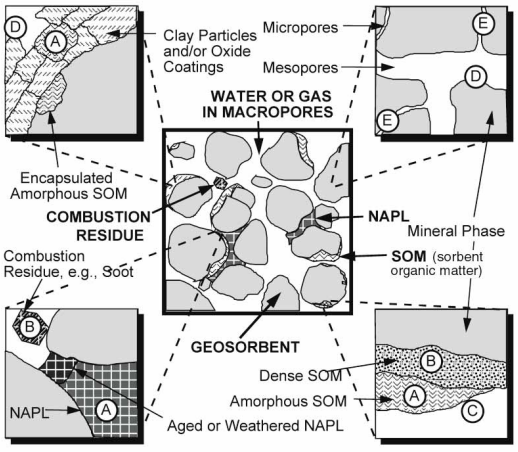
by Dr. Jeffrey W. Talley, Environmental Laboratory, ERDC-WES

There is a great need to understand contaminant-soil interactions and their effect on bioavailability and toxicity of contaminated soils. The adherence and slow release of hydrophobic organic compounds in soils is both an obstacle to remediation and a challenge to current concepts about cleanup standards and risk. These concerns are particularly important for biological treatment of polycyclic aromatic hydrocarbons (PAHs) where one of the most important of the site-specific factors is the availability of PAHs held within solids and how this affects treatment rates and acceptable toxicological endpoints.

A recently concluded study explored mechanisms to control PAH sequestration by using new spectroscopic techniques when examining the distributions and associations, as well as binding energies, of PAHs in soils at the microscale. Collaborators on this project were Dr. Jeffrey W. Talley, Samuel G. Tucker, and John S. Furey at the Environmental Laboratory, ERDC-WES; Drs. Upal Ghosh and Richard G. Luthy, Department of Civil and Environmental Engineering, and Drs. Seb Gillette and Richard Zaire, Department of Chemistry, Stanford University, CA. This government-sponsored research was funded through the Strategic Environmental Research and Development Program (SERDP). The purpose of the study was to correlate PAH associations with the locations and different forms of sorbent organic matter that are believed to play a significant role in the sequestration and bioavailability of PAHs on soils.

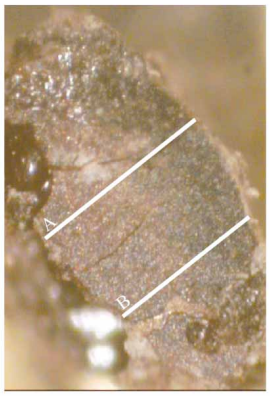
Dredged materials from the Milwaukee Confined Disposal Facility (CDF) were collected and homogenized to provide sufficient sample for 4-month bioslurry treatment testing and for PAH analyses on various size and density fractions before and after biotreatment. Sediment PAH analyses included both whole-sample measurements and, most importantly, the determination of PAH distribution by sediment particle size and type. Physicochemical analyses included room temperature Tenax bead aqueous desorption experiments and thermal program desorption-mass spectrometer (MS) studies to assess PAH binding energies on sediment particle types. Thermal programmed desorption-MS experimental protocols and data reduction techniques were developed to evaluate

Technical Background

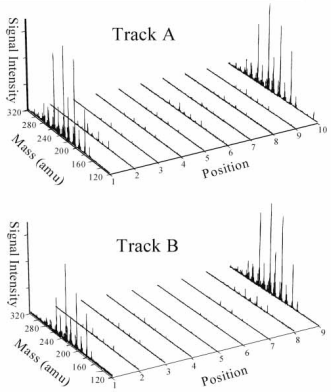


- Conceptual model of where PAHs may reside in soils and sediments
- Physicochemical phenomena responsible for sequestration of PAHs are not well understood

PAH Measurement Inside Particles



Sectioned surface of a coal-derived particle



Spot PAH measurement along tracks A & B using mL^2MS

Thermal Programmed Desorption-MS

TPD-MS instrument with direct insertion probe for particle-scale measurements

Probe with glass crucible

Bioslurry Reactors

- Assessment of PAH biodegradability from sediment particle types
- 2 controls and 4 active bioreactors
- 5L reactors, 30% solids by volume

Additional information about the research and the research team is available from Dr. Jeff Talley, e-mail: *talleyj@wes.army.mil.*

apparent PAH binding activation energies on sediment particles. Microbial ecology testing used polar lipid fatty acid (PLFA) and DNA procedures and radiolabel microcosm studies. Earthworm bioassays studied the acute toxicity effects and PAH bioaccumulation from untreated and biotreated PAH-impacted dredged materials. Overall, the results were used to synthesize and correlate data to assess the availability and treatability of PAHs in dredged sediments.

Results

The significant findings of this work were:

- the release of PAHs is dependent both on PAH molecular weight and the character of the sediment sorbent material;
- two principal sediment particle classes dominated the distribution and release of PAHs - clay/silt and coal-derived;
- PAHs were found preferentially on coal-derived particles;
- clay/silt particles released PAHs more readily than coal-derived particles;
- bioslurry treatment reduced PAHs on the clay/silt fraction but not the coal-derived fraction;
- PAH reduction in clay/silt fractions by biotreatment resulted in significant reduction in earthworm PAH bioaccumulation;
- PAHs on coal-derived particles were associated with high binding activation energies; and
- changes in the phenotype and genetic potentials of the extant microbiota can be used to assess intrinsic biodegradative potential.

Benefits

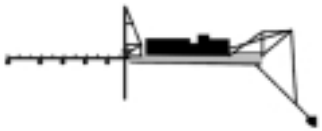
The benefits of this work include:

- scale techniques to assess PAH distribution and behavior;
- improved assessment for the potential success of biotreatment through understanding of factors contributing to available and unavailable PAH fractions;
- improved decision making regarding sediment quality criteria for PAHs and the biotreatment of PAH-impacted sediments; and
- reduced treatment costs and greater likelihood for reuse of dredged sediments through improved assessment of toxicity and risk for PAH contaminants in sediments by use of particle-knowledge of the underlying processes affecting PAH locations, availability, treatability, and toxicity.

Who Should Attend?

- ☆ Dredged material testing, assessment, and management specialists.
- ☆ Federal and State regulatory personnel involved in managing, testing, evaluating, or regulating dredged material.
- ☆ Anyone managing contaminated aquatic sediments.

www.wes.army.mil/el/dots
click on “Training”



Additional information is available from:
Ms. Billie Skinner, 601-634-3701
Dr. Robert Engler, 601-634-3624
Mr. Tom Patin, 601-634-3444

Dredged Material Assessment and Management Seminar

10-12 April 2001

Sheraton Inner Harbor Hotel
300 South Charles St.
Baltimore, MD

sponsored by
U.S. Army Corps of Engineers
and
U.S. Environmental Protection Agency

What is being offered?

The seminar focus is on assessment and testing for waters regulated under the Clean Water Act and the Marine Protection, Research, and Sanctuaries Act. Presentations and discussions will include the following:

- ☆ Regulations and Policies
- ☆ Inland, Ocean, and Upland Testing Manuals
- ☆ Sediment Quality Guidelines
- ☆ Corps/EPA Technical Framework
- ☆ DOTS—Technology Transfer
- ☆ Bioaccumulation Testing and Interpretation
- ☆ Chronic Sublethal Testing and Interpretation
- ☆ Dredged Material Management Software DMSMART
- ☆ Dredged Material Management Models (ADDAMS)
- ☆ Beneficial Uses
- ☆ Risk Assessment Application
- ☆ Research
- ☆ Design and Management of CDFs
- ☆ Innovative Technologies
- ☆ Contaminated Sediment Testing and Management

Hotel Information:

A block of rooms has been set aside under the name "Dredged Material Management Seminar" at the Sheraton Inner Habor Hotel, telephone 410-962-8300. Government rate of $110 single or double (or pd rate in effect at the time of the seminar) plus tax will be available to eligible attendees. **Participants must make their reservations no later than 9 Mar 2001**.

It is recommended that attendees use the BWI Super Shuttle service from the airport to the hotel at $17 round trip. Shopping, attractions, and restaurants are within walking distance of the hotel.

How do I register?

Seminar registration: There are four ways to pre-register for the seminar:

- ☆ By FAX at 601-634-3528
- ☆ Via e-mail at skinneb@wes.army.mil
- ☆ Online at *www.wes.army.mil/el/dots/training/register.html*
- ☆ By mail:

  USAERDC, WES
  ATTN: Ms. Billie Skinner, EP-D
  3909 Halls Ferry Road
  Vicksburg, MS 39180-6199

Your registration must provide:

- ☆ Full name
- ☆ Organization and address
- ☆ Telephone number
- ☆ FAX number
- ☆ e-mail address

Pre-registration for the seminar ends on **16 February 2001**. Pre-registration is highly recommended to ensure attendance. It is recommended that attendees take advantage of the DOTS Online Institute training in preparation for the seminar. It can be accessed at:

http://www.wes.army.mil/el/dots/training.html

Onsite registration will be 3:00-5:00 pm on 9 April 2001 and 6:30-8:00 am on 10 April 2001. The seminar will commence at 8:00 am on 10 April and conclude at 5:00 pm on 12 April.

DOER creates CD-ROM for quick publication access

A DOER compact disk, capturing all DOER publications through August 2000, has been published and is now available as long as supplies last. The .pdf-based files are accessed through an on-disk copy of the August 2000 version of the DOER web application.

The CD also contains the DOER slide show, which presents an overview of the program and its research goals. One version of the slide show includes audio text that summarizes accomplishments achieved by August 2000 in the six focus areas of the program.

To obtain a copy of this CD-ROM, contact Shirley Walker at 601-634-2864 or e-mail *walkers@wes.army.mil*.

Dredging Calendar

2001

January 7-11 - Transportation Research Board 80th Annual Meeting, Washington, D.C.
POC: *www.national-academies.org/trb/meeting*

April 10-12 - Dredged Material Assessment and Management Seminar, Baltimore, MD, sponsored by U.S. Army Corps of Engineers and U.S. Environmental Protection Agency,
Register online at *www.wes.army.mil/el/dots/training.html*

April 1 - Call For Papers: PIANC 30th International Navigation Congress. Abstract to be submitted by April 1.
POC: *www.pianc-aipcn.org/pi200.html*

April 2-5 - WODCON XXI Congress, Kuala Lumpur, Malaysia.
POC: *www.woda.org*, click on "Congresses."

April 29-May 2 - Ports 2001, Norfolk, VA., ASCE/PIANC.
POC: *www.asce.org/conferences/ports01/index.html*

June 24-27 - 21st Western Dredging Association (WEDA) Conference; Texas A&M University's 33d Annual Dredging Seminar; and PIANC Session - Houston, TX
POC: 360-750-0209, *www.wesda.org*

July 15-19 - Coastal Zone 2001, Cleveland, OH.
POC: *www.csc.noaa.gov/cz2001*

October 1-5 - AAPA 2001 Annual Convention, Quebec City, Canada,
POC: *www.aapa-ports.org/conventions.html*

October 22-26 - Convention on the Prevention of Marine Pollution from the Dumping of Water and Other Matter, London Convention of 1972, London, UK. (attendance for Convention Members only)

2002

September 22-26 - PIANC 30th International Navigation Congress, Sydney, Australia

Articles for *Dredging Research* requested:

Dredging Research **is an information exchange bulletin for publication of ERDC-generated dredging research results. Included are articles about applied research projects. The bulletin serves all audiences and is accessible on the World Wide Web in addition to a paper circulation of 2,800.**

Articles from non-ERDC authors are solicited for publication, especially if the work described is tied to the use of ERDC-generated research results. Research articles that complement ERDC research or cover wide field applications are also accepted for consideration. Manuscripts should use a nontechnical writing style and should include suggestions for visuals and an author point of contact. Point of contact is Elke Briuer, APR, at *briuere@wes.army.mil*.

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Dredging Research

This bulletin is published in accordance with AR 25-30 as an information dissemination function of the Environmental Laboratory of the U.S. Army Engineer Research and Development Center. The publication is part of the technology transfer mission of the Dredging Operations Technical Support (DOTS) Program and includes information about various dredging research areas. Special emphasis will be placed on articles relating to application of research results or technology to specific project needs. The contents of this bulletin are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or the approval of the use of such commercial products. Contributions are solicited from all sources and will be considered for publication. Editor is Elke Briuer, APR, *briuere@wes.army.mil*. Mail correspondence to the Environmental Laboratory, ATTN: DOTS, *Dredging Research*, U.S. Army Engineer Research and Development Center, Waterways Experiment Station (CEERD-EP-D), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, or call (601) 634-2349. Internet address: *www.wes.army.mil/el/dots/drieb.html.*

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Director

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